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Subject Category: RADIOACTIVE WASTE

UNITED STATES ATOMIC ENERGY COMMISSION

FOURTH ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT ARGONNE NATIONAL LABORATORY, NOVEMBER 1955

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Division of Reactor Development
Washington, D. C.

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DIVISION OF REACTOR DEVELOPMENT
Washington D. C.

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AIR CLEANING PROBLEMS AND ACTIVITIES AT THE GOODYEAR ATOMIC CORPORATION, PORTSMOUTH, OHIO

By Howard Caterson

LOCATION AND DESCRIPTION OF PLANT

As many of you know, the Goodyear Atomic Corporation operates for the Atomic Energy Commission a gaseous diffusion plant located in Pike County, Ohio just 20 miles north of Portsmouth and the Ohio River. The plant was built at the direction of the Atomic Energy Commission for extracting uranium-235 isotope from various isotopic assay mixtures of uranium. The area of Southern Ohio in which the plant is located is thinly populated and essentially rural. In Pike County, where the plant is located, the 1950 census showed Waverly with a population of 1700 inhabitants as the largest town. Prior to construction of the plant, most of the county's population was engaged in agricultural activities. Although not perhaps as isolated as Los Alamos, or some of the test sites in the west, there seems to be ample area with sparse population between the plant site and the principal communities. So that you may better orient yourselves, I have marked on the map (Fig. 1) the principal residential areas - Portsmouth, Lucasville, Beaver, Piketon and Waverly.

The plant itself is located on a 4000-acre site and consists of three large process buildings and an assortment of auxiliaries. The dimensions of a typical building are 2,500 feet long by 500 feet wide.

PRINCIPAL AIRBORNE CONTAMINANTS

Uranium and fluorine, in several combinations, are the principal airborne contaminants which might result from the plant operations. I might mention that the diffusion cascade itself consists of a vast configuration of relatively large diameter pipes, vessels and gas pumps which continuously circulate uranium hexafluoride in gaseous state. Except at the time of equipment or pipe failure, the uranium gas is contained in the cascade system. Process gas can, of course, escape accidentally at the feed point and at the withdrawal points. In the presence of wet air, uranium hexafluoride will hydrolyze to an oxifluoride or reduced to the insoluble tetrafluoride. Under normal atmospheric conditions, these compounds are solid and can form small particles which easily become airborne. The other gaseous contaminants consist of fluorine and hydrogen fluoride. Fluorine and hydrogen fluoride may be associated with or without uranium.

CONTAINMENT OR DISPERSION?

There are two directly opposite philosophies prevelent at our plant on the subject of airborne uranium contaminants. Should the released material be contained and collected at the point of disposal or should the airborne material be exhausted to the atmosphere so that the area concentration is reduced by dilution? Containment usually requires more equipment and is frequently more expensive. Containment, however, will prevent widespread contamination and will enable easier recovery of airborne materials.

URANIUM GAS RELEASES - LARGELY CONSIDERED INTERNAL

It has been noted that the airborne activity following a release of process gas (UF_6) tends to decrease more rapidly at the U-235 depleted end of the cascade than at the U-235 product end. The complete reason for this is not known at this time. The rapid settling of particulate matter after a release does permit entry by decontamination personnel wearing company-issued clothing and shoes. Respiratory equipment is usually used for protection against ingestion brought about by dusts stirred up during the cleaning activity.

Uranium gas released in an enclosed area handling higher assay material from the cascade does require ventilation to reduce the airborne activity. This higher assay material is sufficiently valuable that a filtering system is being installed for collection and recovery of the uranium. Since the alpha activity of this material is very high, the dollar value is considered fortunate from an industrial hygiene point of view. It is proposed that several deep bed fibre glass filter units be used as the filtering agent. It is believed and hoped that the routine changing of the filters will not give the fluorides sufficient time to attack the filter media. In one such area where this problem exists, the ventilation provided by operating air samplers within the enclosed area is sufficient to reduce the airborne activity. The filter papers collecting the airborne contaminants are processed to recover the uranium. This is an interim measure until the permanent ventilation system is installed.

In the room where depleted uranium hexafluoride is withdrawn from the cascade, the airborne activity following a release decreases rapidly. There are two ventilation systems in the area - one, over each withdrawal point, designed to handle small releases, and the second, an emergency system located in the ceiling designed to exhaust any major release to the outside. It is the philosophy of our Health Physics Department that when the contaminant is contained, there is no necessity to spread it over a large area. Therefore, it is their recommendation that the emergency ventilation system be used during a major release only when needed to facilitate the evacuation of personnel from the area.

In our product withdrawal area, vacuum pumps were provided, preceded by mechanical and chemical traps, to exhaust within the rooms. After a brief period of operation in this facility it was discovered that the traps did not remove all of the uranium hexafluoride gas and it was being dispersed in light concentrations throughout the room. The vacuum pumps have since been connected to vent lines exhausting them to the outside. Because of the monetary worth of even the small quantity of vented uranium, filters are being designed to collect material which passes through the pumps.

THE AIR CLEANING PROBLEM

An extensive ventilation system is provided in each process building (8,300,000, 8,750,000, 7,000,000 CFM respectively) to control and maintain ambient air temperatures in order to prevent the process gas (UF_6) from freezing out and to provide air for cooling motors. Air mixing and filter rooms are provided at the air intake openings into the buildings. A typical process building will include some 7,600 20" x 20" x 2" viscous type wire mesh filters (American Air Filter Type HV-2 - Design A - 1200 CFM per filter capacity). The filter banks are washed clean with warm water and reoiled when the static pressure drop reaches 0.25" of water (design point - 0.12" of water). Reoiling has been a fire hazard when improper spraying devices are used. On one occasion, atomizing spray heads were used resulting in large quantities of oil vapor being carried into large portions of the building. Suggestions of uninflammable oils for consideration in this application would be welcomed. Although the above certainly represents an extremely large industrial ventilating installation, there are no unique radiation or nuclear problems directly associated with this application.

EXTERNAL ATMOSPHERE CONTAMINANTS

Fluorine and other light mass gasses such as nitrogen or air, must be removed from the cascade to prevent an excessive build-up of volumes which should better be occupied by uranium gas. The removal of these so-called "lights" is accomplished by allowing the gasses to vent through stacks. There has been, over the months, a build-up of radioactivity around the vents from traces of uranium passing through with the "light" gasses.

Until an adequate scrubber is designed for fluorine being vented, it is proposed to allow the vent gases to pass directly into the atmosphere. The odor threshold for the various fluorine components is considerably below the plant limits (1PPM); as a result, nearly everyone on plant site has a more sensitive detector than the Industrial Hygiene Department. Even though background checks for fluoride contents of mud, water, foilage and air indicate no change over the initial values observed prior to beginning plant operation, both off and on plant site, plans for fluorine scrubbers are being developed.

These application items and problems which I have just discussed are mentioned to give you a cross section of typical problems associated with airborne activity at the Portsmouth plant site. Although some of the materials are not commonly used in other industries, it is not claimed that Portsmouth's problems are unusually difficult or particularly unique. We are confident that the bulk of these problems have and will continue to be solved using standard industrial hygiene and engineering techniques.

FUTURE CONSIDERATIONS

Although the plant site is located in a sparsely populated area, there are privately owned lands and farms on all sides of the plant site. Our Industrial Hygiene and Health Physics Groups regularly check plant effluent streams and take air samples from regular points. In addition to this monthly data, arrangements have been made for annual photographic surveys as a check to determine whether airborne radioactive materials and corrosive gases have had any effect on foilage and crops. The first aerial and ground photographic survey was made before plant operations began in 1954 and the second survey was completed this past summer. As expected, no apparent changes have yet been detected.

Several unanswered problems have been mentioned and I hope that perhaps in some of the discussions here this week I might pick up some clues which will give us some help. Among these unanswered problems were the absolute removal of uranium hexafluoride by banks of mechanical and chemical traps; the best filter media to be used for the collection of uranium fluorides and for the scrubbing and collection of fluorine from vented gases. In addition, a method which would analyze fluorides quickly and accurately is needed. Our Laboratory people report that the present modified Williard & Winters Titration Procedure requires a time consuming distillation and gives much delayed results.

In summary, I would like to say that during the start of operations at the Portsmouth Plant there have been many interesting problems in the area of air contamination and air cleaning. The bulk of these center around uranium and fluorine compounds and the bulk of the solutions have been handled by dispersion and dilution. Trapping has been successful, although improvements are in order. It is not anticipated that difficulties in the near or foreseeable future with the community will result from the present methods of operation at the Portsmouth Area Plant.

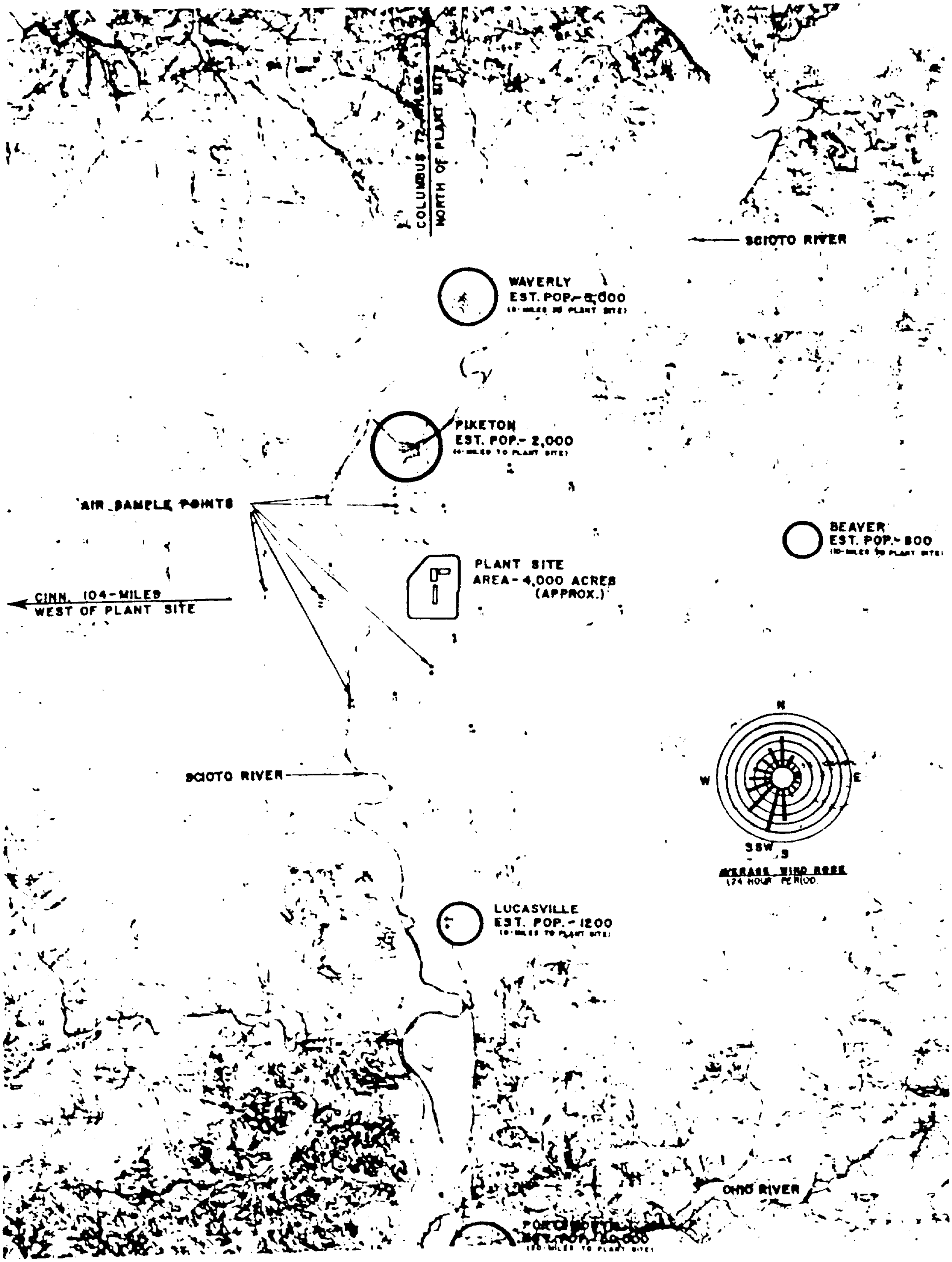


Fig. 1 -- Principal Residential Areas.

"SPECIAL AIR CLEANING AND VENTILATING EQUIPMENT FOR SPECIAL MACHINING OPERATIONS"

Argonne National Laboratory
November 3, 1955
by
M. D. Thaxter, UCRL Berkeley

Machining oralloy shapes for experimental devices or for weapons components poses a number of problems suggesting specialized engineering solutions.

These problems may be listed:

1. Dimensions of the work piece are such as to require a versatile size #2 milling machine.

2. High degrees of precision machining may be required, necessitating fine finish cuts, frequent inspection, good visibility, and expert operators.

3. Toughness of the metal is notorious, necessitating relatively massive, hence expensive, precision tools, amply powered and with abundant lubricant and coolant.

4. Oralloy is not 100% pure U^{235}. Oralloy is of course radioactive. The U^{234} impurity increases its radioactive hazard when inhaled or ingested. Penetrating radiation, both beta and gamma, is such that workmen should limit their close contact to work pieces and to chips to a minimum.

5. Criticality considerations are frequently controlling as to design and operations. The effect of moderators and tampers must be forseen. In fact, the near presence of the operator, due to the hydrogenous constituents of his body, may preclude certain shapes. Subdivision of the work piece, as in chip formation, can change the critcality of the array rapidly. A gross subdivision, as in a fire, followed by collection of the finely divided oxide in water may promptly change a subcritical configuration to above critical.

6. Oralloy idizes easily. This property is enhanced by local temperature increases (as n machining) and is further intimately related to the available surface. At room temperature in air oralloy masses will promptly develop an oxide coating which is self-limiting in depth. Exposure of a new surface is followed by additional oxide formation. This reaction is strongly exothermic. If in machining operations this temperature rise is not controlled rigidly, combustion commences and may proceed very rapidly. Under combustion conditions, uranium metal will remove oxygen from water, carbon dioxide, carbonates, and of course from air. An established uranium fire in air may be practically impossible to put out.

7. Accountability standards established by the AEC for Oralloy requires recovery of all scrap within "reasonable" limits for the operation concerned. This may mean fractions of a gram. At a published $25.00/gram there is also an economic incentive to suffer no appreciable losses in processing. Scrap may not be poisoned by cadmium, boron or other neutron-absorbing contaminants which could hinder reprocessing.

8. As an eighth item, although not a problem peculiar to oralloy machining, the following philosophy enters into the engineering. All radioisotope processing (whether mechanical or chemical) at UCRL is held to the criteria that work rooms shall be contamination free; that special protective suits, respirators, clothing, etc., shall be for emergencies only and that contamination potentials shall be engineered to confine the problem to its locus and not to permit planned or probable dispersal.

Design of the milling machine facility:

The salient features of the mill and its enclosure may best be presented by showing a few slides (Chem 2802 - 45° front view): a #2 mill is modified to include a special table for chucking the work piece. This table is surrounded with a coolant pan to hold a 2" lake for quenching and submerging the bulk of chips. Surrounding all is a five sided enclosure fastened to the table. The front side is lucite with glove ports mounted in a rotary plate and with one access door leading to an internal crane. The two ends have access doors. (Slide 2800 - front view) (Slide 2801 - back view) The back is a stainless sheet rolling onto vertical shafts under tension. Top, bottom and sides of the sheet are sealed with Teflon wipers. This enclosure can therefore rise and fall, traverse, and proceed front to back with the same scope as the original milling machine. Major controls are external to the enclosure. Coolant is supplied at 4 GPM. An "Ansul" dry chemical system is installed for fire suppression.

The enclosure is deemed to supply a reasonable compromise with the machinists' habits and requirements and those dictated by the "problems" above enumerated. It is the subject of AEC Accident and Fire Prevention information Issue No. 19 October 10, 1955.

Design of the air cleaning facility:

The air cleaning design, as to capacity, is dictated by the area of opened access doors. A 50 FPM velocity was selected for all 3 doors open--a rare possibility. This gave us 300 CFM.

Because of the complexity of operations and sizes of pieces, an early hope to exhaust the cutter area under close capture conditions was abandoned in favor of general enclosure exhaust.

The rigorousness of design to be described is dictated by the worst possible air cleaning eventuality--a massive out-of-control conflgration in the milling enclosure. Such an event would discharge abundant heat and a dense cloud of glowing uranium oxide to the exhaust train. Clouds with these properties have in practice already plugged filters and then burned through or melted down adjacent structures. It was therefore decided to install a "quencher" early in the system. We selected the perforated double-plate inertial separator (sold under the name "Neva-Clog") which, when employed with flooding nozzles delivering distilled water coolant at 10 gpm is estimated to be adequate for quenching and placing into water suspension a very large fraction mass-wise of uranium or uranium oxide so airborne.

The coolant is drained from both upstream and downstream faces of the separator to a cadmium clad trifurcated sump the dimensions of which comply with criticality requirements. A siphon from one element returns the circulating coolant to a neoprene impellor pump and back to the flooding nozzles.

Downstream airwise of the separator is a glass fiber filter pad (PF 105) as an "accountability" collector for that fraction of uranium particulates passing the separator. Downstream of it is a high temperature resistant fibrous pad made of "Fiberfrax" employed as a fire stop.

Downstream of the fire stop filter is an all-glass fiber clean-up filter of 1106 B paper in the familiar CWS pleated pattern.

An exhauster adequate to overcome the various pressure drops encountered discharges to an ordinary sheet metal duct exhausted to outdoors.

Controls include a low level sump alarm, a coolant flow alarm, the usual electrical fusing and panel lights denoting energized motors or the contrary. Manometers indicate pressure drops across the air cleaning elements.

An emergency air flow restriction valve, spring loaded, may be activated by the operator to cut CFM from 300 to 70.

Access ports are provided for viewing, for wash down and recovery as well as for monitoring.

A periodic shut-downs the coolant pump circuit may be tapped via Saunders valves into a porous stainless steel plate acting as support for a filter on which fines can be recovered for accountability weighing.

The assembly just described is a mobile unit (as are most of the UCRL radioisotope processing units, where possible). To accomplish this, many liberties had to be taken with good aerodynamic concepts otherwise the unit would--on a straight line arrangement--have extended to 62 feet long. Actually it is 4'6" x 4'8" x 6'6" high. Slide 441 shows a side elevation featuring the control panel. Slide 442 shows a side elevation featuring the sump and Slide 444 is a top view. It is anticipated this air cleaning unit will also be employed on other machines such as lathes, drill presses, etc. Although considerable thought and effort has been expended we recognize this is our Mark I model and some changes may be dictated by operating experience. We would like to present some numbers derived from experimental runs, however. In one of these several hundred grams of uranium chips were deliberately ignited into the system (Table I)

It is a pleasure to acknowledge the assistance received from the past three air cleaning seminars and specifically from the Harvard University's School of Public Health Air Cleaning Laboratory. We are also indebted to the N.Y.O.O. Industrial Hygiene Labs under W. Harris for his experience and data on uranium machining. Mr. Jack Murrow, chemist in our group is to be praised for his competent efforts in experimentation and design and for his coordination of the various detailers and technicians.

I particularly wish to express personal satisfaction in working under a Chief, Nels Garden, who invites problem solutions not necessarily rooted in technological antiquity.

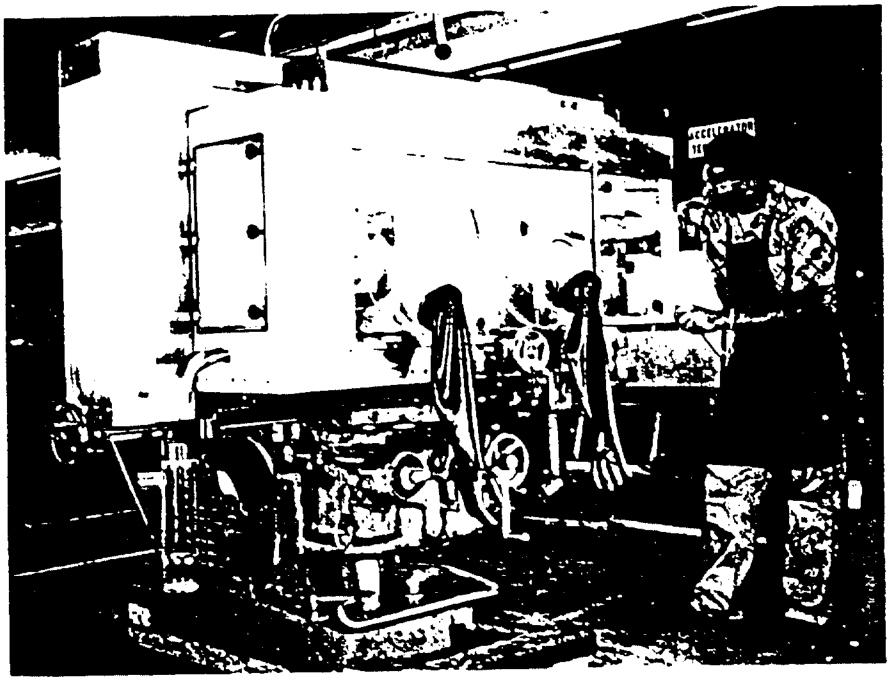
TABLE I

Operating Data

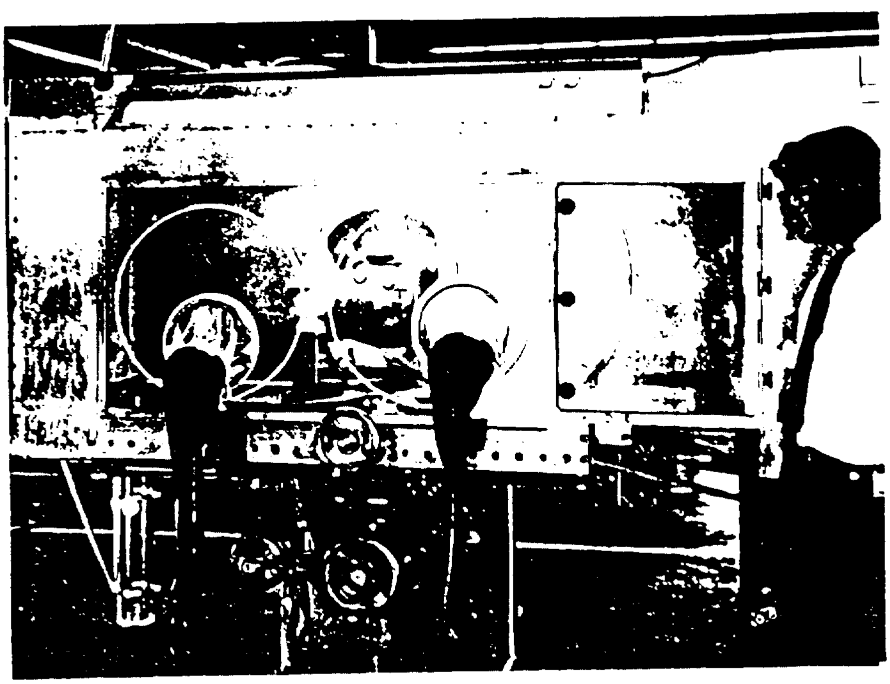
ITEM	Cross Sectional Area ft^2	Velocity: Air @340 CFM FPM	Velocity: Water	Pressure Drop Inches Water: Operating @ 340 CFM	Pressure Drop Inches Water: Design @ 300 CFM	Inlet: Wet Bulb °F	Inlet: Dry Bulb °F	Inlet: Rel. Humid. %	Discharge: Wet Bulb °F	Discharge: Dry Bulb °F	Discharge: Rel. Humid. %
Inertial Separator	2.37	145	3.2-5.5 gal/ft²	5-6	5-6	56	68	48	60	72	50
Recovery Filter	4	85	-	0.9-1.3	2	At above typical conditions and at 340 CFM approx. 1/4 gallon of water would be evaporated per hour.					
Firestop Filter	1	340	-	2.6-3.0	1-1.5						
Clean up Filter	4	85	-	0.7-0.9	0.5						
TOTAL	-	85-2300	7.5-13 gpm	13.6	13.5						

CONSTRUCTION DATA

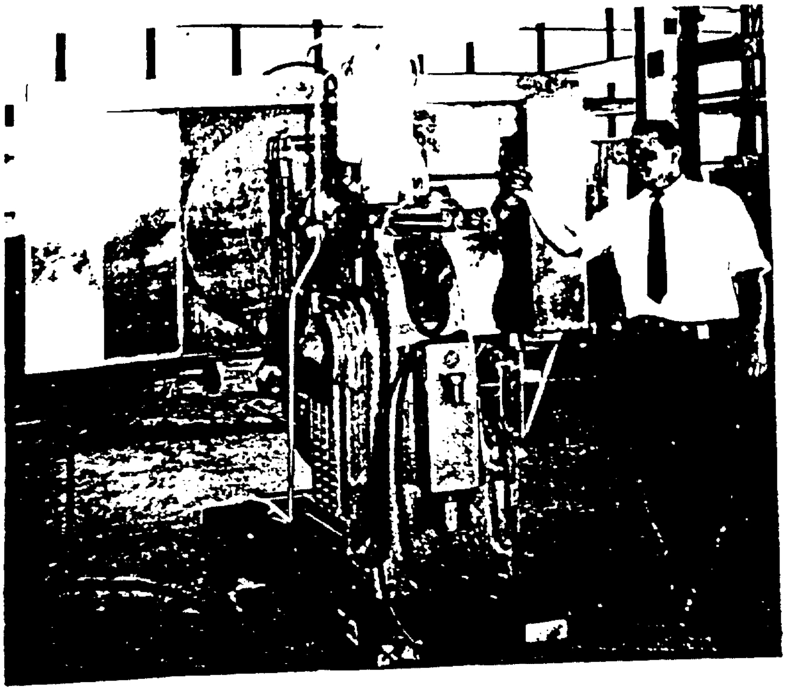
Exhauster	McKee-Eclipse Centrifugal Pressure Blower #1-6515-1½, 3600 RPM @ 1½ HP, 440V, 3∅ Rated capacity 400 CFM 13.75 inches #20
Pump	Jabsco, 1¼", Model FM, Bronze body, Neoprene impellor, S.S. Shaft, 900 RPM 1 HP Rated capacity 14.1 gpm @ 32 psi
Pipe	1¼ copper water tube, type L. Velocity - 3-3.5 fpm
Outside Purchases	$1100.00
Materials	approx. $225.00
Labor	56 man days (designing not included)



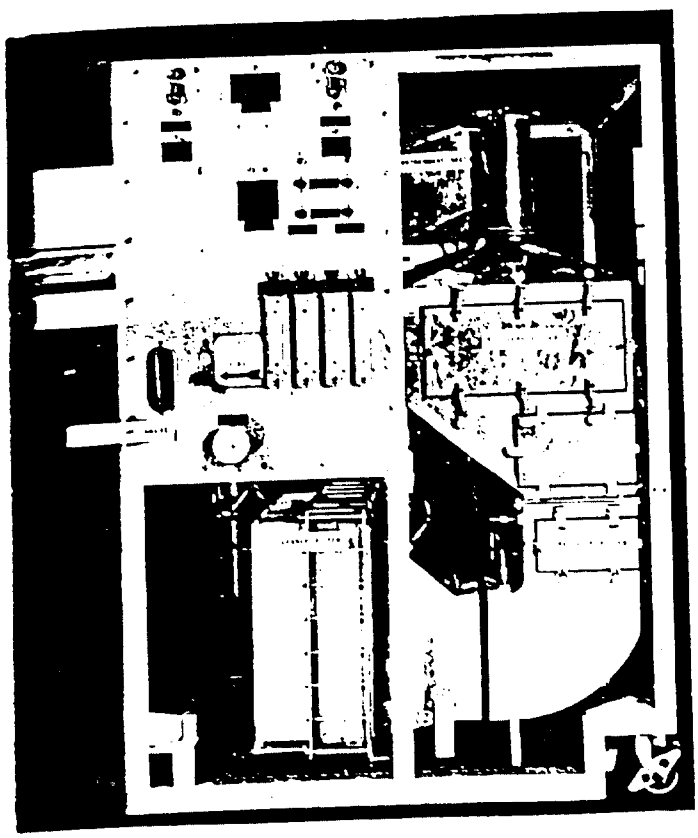
Slide 2802--45° Front View



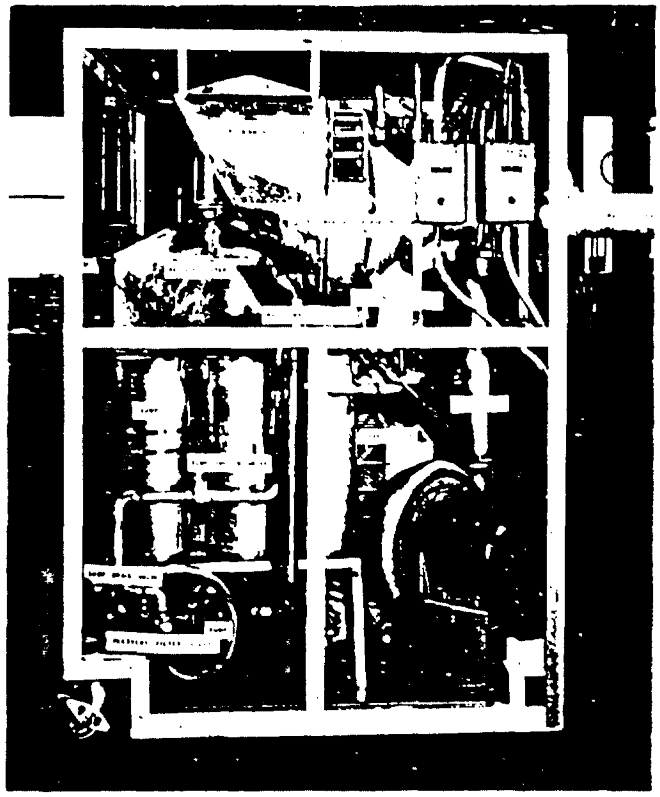
Slide 2800--Front View



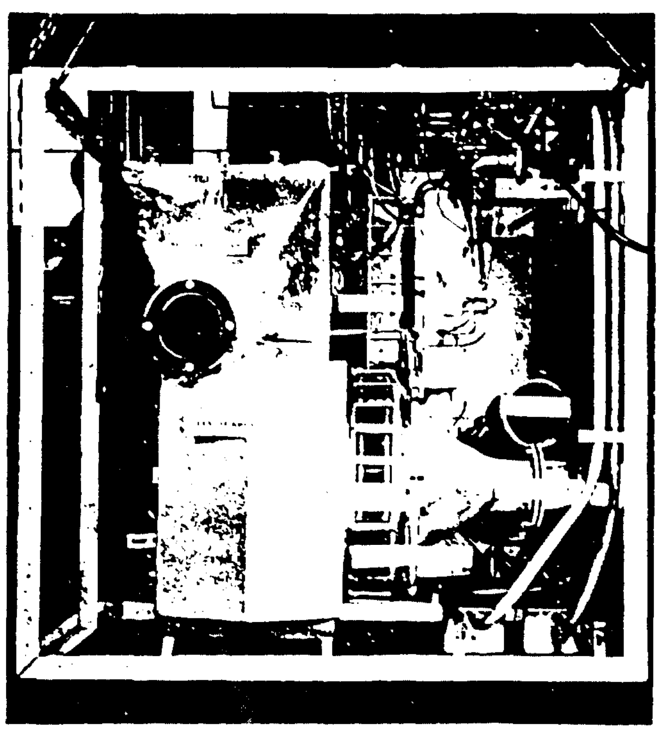
Slide 2801--Back View



Slide 441



Slide 442



Slide 444

AIR CLEANING AND INERT ATMOSPHERE VENTILATION SYSTEMS FOR FACILITY 350

by

A. B. Shuck

The Argonne National Laboratory Fuel Fabrication Facility will be a plant for development and fabrication of reactor fuel components containing plutonium or uranium-233. It is not, as has been rumored, a refabrication plant for irradiated fuels. The Facility will be housed in a building 245' long by 72' wide. The first floor plan of this building is shown in Figure 1. It is divided ventilation-wise into three areas which, for reference, we have termed the Administration Area, the Technical Area, and the Fabrication Area.

The Administration Area consists of a lobby, offices, counting room and clothing change rooms. This area is considered to have the same likelihood of contamination as any office or street area in the immediate vicinity of a closely controlled radioactive materials laboratory. The area will be air conditioned and ventilated as any uncontaminated area. The Technical Area will contain storage vaults for radioactive materials, a mechanical laboratory used for maintenance or modification of equipment and tooling, x-ray rooms, dark rooms, and a Health Physics Department work and storage room. No direct work upon radioactive materials will be done in this area and contamination will be the result of a handling accident or of tracking contaminated material from the Fabrication Area.

The Technical Area is isolated from the Fabrication Area, from the Administration Area, and from a Shipping and Receiving dock area by means of air locks with interlocked doors. The Fabrication Area will be used for all work performed directly upon radioactive materials or upon clad fuel elements containing radioactive materials and, while every effort will be made to keep all personnel areas free of contamination, the contamination risk will be greatest in the Fabrication Area. Air will be supplied to each of the areas by means of separate air conditioning systems. A multizoned air conditioning system will be used for the Administration Area and zoned air conditioning systems will be used for the Technical Area and for the Fabrication Area. Replaceable medium type roughing and secondard filters will be used on all air supplied to the Technical Area and to the Fabrication Area. The roughing filters will consist of 32 24" x 24" x 9" filters in V-arrangement. Each roughing filter will be American Air Filter Company 5 ply type F Air Matte fireproof medium. The secondary filters, 32 in number, and 24" x 24" x 9", will be American Air Filter Company 10 ply type Air Matte filter medium. Similar filters will be installed for ventilation of the fan room. The air will be dehumidified by cooling and then reheated. A maximum absolute humidity equal to 50% relative humidity at 80°F has been established.

The transmission of air borne contamination between areas will be controlled by the usual methods of ventilation and pressure control. The

Technical Area will be established as a reference zone against which the pressure of the Fabrication Area and the Administration Area will be controlled. The pressure of the Technical Area will be maintained at approximately 0.05" w.g. below the ambient barometric pressure. This will be established as a dynamic pressure-air flow relationship by throttling the air supply to a flow slightly less than that of the exhaust air. The area has no openings to the outside or to the other areas except through the air locks. The regulation of the air flow to produce the desired pressure will necessarily be a field adjustment since at this time there is no way of accurately determining the leakage rate of the zone. It is felt that this method will establish a more uniform pressure than if referenced to the wind sensitive outside air pressure.

The pressure in the Administration Area will be controlled by modulation of the vortex damper on the exhaust fan against the pressure of the Technical Area by means of a differential pressure regulator set at +0.05" referenced to the Technical Area. The pressure in the Fabrication Area will be controlled at -0.075" w.g. referenced to the pressure of the Technical Area by means of the differential pressure regulator modulating a vortex damper on the room air exhaust system.

The Fabrication Area will contain equipment for alloying, melting, casting, rolling of shapes, plate and foil, wire fabrication, pressing, extruding, heat treating, and surface treating of plutonium alloys. This equipment will be housed in the system of interconnecting, gas tight, hood lines. Each hood line will be connected to a back-bone hooded conveyor by means of a pneumatically operated sealing door. Access to and egress from the system will be by means of an especially designed hood line with provision for air lock insertion of uncontaminated material and for sealing contaminated material in plastic pouches for extraction from the hood system. Additional equipment will be provided for canning, welding, and bonding of the radioactive metals into the nonradioactive jacketing materials, for machining, welding, brazing, and shearing of the clad fuel elements and for fabrication of finished fuel assemblies. The operations upon the clad fuels will be carried out in individually hooded equipment which will be separated from the contaminated hood system. The layout of the hoods in the Fabrication Area is shown in Figure 2.

Since the equipment housed is larger than that ordinarily hooded, various methods of protecting the operating personnel from exposure to the alpha radioactive materials were considered in the preliminary studies for the Fuel Fabrication Facility. The glove box approach to the problem was decided upon mainly because there is more background of experience with this method at ANL and at other installations from which to draw and because it appeared to offer the maximum of process flexibility while affording satisfactory protection to the working personnel.

The heavy equipment in the Fuel Fabrication Facility requires large sturdy enclosures. Accordingly, a flexible, modular enclosure system was developed using aluminum extrusions for a rigid frame with heavy transparent plastic or aluminum panel inserts in place of the usual light sheet metal construction. A prototype of this enclosure is shown in Figure 3. All of the enclosures were designed with gloves on both sides and enclosed a space width of 48". The frames were fabricated from the five aluminum extrusions shown in Figure 4. The extrusions incorporated gasket grooves, window recesses, bolting flanges, and ventilation passages in the as-extruded shapes. Details of the hood construction will be available in a forthcoming ANL report.

The ventilation of the Fuel Fabrication Facility consists of the following systems: Two-once through systems for ventilating (1) the alpha radioactive hood lines and (2) the clad hood lines. Two emergency stand-by or purge systems for ventilating (1) the alpha radioactive hood lines and (2) the clad work hood lines. A once through filtered air system to exhaust the room air and ventilating the equipment housed in the enclosures below the primary hood system.

The hoods in which the unclad radioactive materials are worked will be operated at a negative pressure of between 0.6" and 0.8" w.g. whether operated on air or inert gas atmosphere. When the hoods are to be air ventilated, the pressure will be controlled by drawing a maximum of 120 cubic feet of room air through two 12" x 12" x 6" AEC fireproof medium filters at the outer end of each hood line. Outlet and inlet dampers will be manually adjusted to produce the required pressure. The filtered air will be distributed through hollow cavities in the lower longitudinal extrusions and will be introduced to the hood modules through slots with adjustable cover plates to regulate the amount of air to each module. The air will ventilate the hood and will be withdrawn through similar slots in the upper longitudinal extrusions and then will be carried through the extrusions and piped to the outlet filter housing located just above the conveyor hood. Updraft ventilation is used to facilitate heat removal. Both the inlet and the outlet filters will be changed into the hood system. After filtration through a 12" x 12" x 6" high efficiency fireproof filter, the air will pass a rubber lined butterfly control valve. This valve will serve the dual function of providing positive shut-off of the air system when the hoods are operated on inert gas and as a balancing damper for air operation. The air will then pass through a short run of pipe to the main exhaust ventilation header which will be maintained to the static pressure of approximately -2.0" w.g. It will then pass through a bank of final AEC high efficiency fireproof filters in the fan loft, through a vortex damper controlled exhauster and will be discharged to a common discharge header connected to a 100' stack outside of the building.

Safe operation and filter changing required complete stand-by equipment and it was determined early in the design studies to extend the stand-by equipment into a true emergency system capable of taking care of accidental or deliberate break in the main hood barrier. This system will consist of a purge blower which will operate continuously at essentially no flow. A pre-filter and final filter system installed in the fan loft will be capable of handling up to 3000 cubic feet of gas. The purge ventilation system at the hood will consist of a gas tight, rubber lined, 10" butterfly valve operated by a pilot-positioned damper motor and controlled by means of a pneumatically operated static pressure regulator with one control tip within the hood and a reference tip within the room. The controller will be set to maintain approximately 400' per minute face velocity across an opening into the hoods but, when the hoods are operating at - .6" to - .8" w.g., to close the valve fully and to seal. Four hundred feet per minute velocity will be maintained through an opening of less than seven square feet. The removal of the window will open an area of approximately 10 square feet and will reduce the velocity to 300 feet per minute. If two windows are removed from any hood line or from two hood lines, the velocity will be reduced to approximately 150 feet per minute which is considered the minimum to prevent the outward diffusion of contaminated particles. Separate purge systems will be provided for the alpha radioactive materials hood systems and for the clad work hood system. Both systems will be similar in function. Final filtration will be through two banks of four 24" x 24" x 12" AEC fireproof medium filters in series. The first filters of each series will be changed by the plastic pouch technique.

The room ventilation will be a once through system. The excess building ventilation not required for ventilation of the primary glove boxes will be carried through paneled spaces below the hoods to cool and ventilate the contamination risk equipment housed within these spaces. A slight negative pressure will be maintained in the spaces by the introduction of air to the enclosures through special glass wool filters. The air leaving the spaces will be prefiltered through similar glass wool filters before exhausting to the general building exhaust system. The final filters of the general building exhaust system will be of the AEC high efficiency type. Thus, it will be seen that all air leaving the primary hood systems will be twice filtered through AEC high efficiency fireproof filters but the general room exhaust air will be prefiltered and then finally filtered through AEC standard high efficiency filters.

The Inert Atmosphere System

Originally it was thought that a straight system of air ventilation of the primary hoods for Facility 350 with local helium or argon supplied to small chip collectors or work enclosures would be sufficient to prevent burning and oxidation of the plutonium alloys. Subsequently, it developed that many of the alloys under consideration were spontaneously pyrophoric and, for this reason, these alloys cannot be fabricated in the other AEC facilities. It became necessary to expand the inert atmosphere system and to investigate various possibilities for producing an economically operated inert ventilation system serving entire hoods and hood lines. (This problem has already been solved on a smaller scale in the Plutonium Physical Metallurgy Laboratory at ANL.)

Several gases were suggested for use as a protective atmosphere, including nitrogen, CO_2, synthetic hydrocarbon atmospheres, hydrogen, argon and helium. Of these, only argon and helium were found to be of use. Argon gas has the advantage of being of the same order of density as air and thus can be handled by fans and blowers designed for air, but purification of argon is somewhat of a problem. Regenerative adsorptive systems do not work well with argon since argon is adsorbed nearly as readily as oxygen and nitrogen. Chemical purification methods may be applied but have the disadvantage of involving the handling and disposal of large quantities of reactive alkali or alkaline earth metals which almost certainly will become radioactively contaminated and which by the nature of the process, form high melting temperature sludges which tend to clog the purification system. The operation of an argon liquifying and rectifying system was suggested to obtain high purity argon and to eliminate other gases but this appeared to be a costly expedient.

Helium gas has certain disadvantages. Its low density makes it difficult to circulate by means of fans or centrifugal blowers. Its high diffusivity makes it somewhat more difficult to contain than the heavier gases. The high ratio of constant pressure to constant volume heat capacity ($k = 1.66$ for helium as compared to $k = 1.4$ for diatomic gases) causes the temperature to increase much more in compression than does that of the other gases. The negative Joule-Thompson coefficient causes the helium to heat slightly upon free expansion through an orifice or expansion valve. The principal advantage of the use of helium is that regenerative adsorption methods of purifying it produce good yields and high cleanup factors. This final factor influenced our decision to use helium.

The present plans call for the use of a recirculating helium atmosphere which can be used interchangeably with the once through air ventilation in the various hood lines connected to the conveyorized alpha radioactive hood system and in the welding and liquid metals hood lines. The helium will be recirculating by means of seven stage turbocompressors with an aftercooler after each compressor. These compressors will be piped and valved so that they can be used independently, in parallel, or in series.

The helium gas will be purified by adsorption of the moisture on activated drying agents (silica gel and activated alumina). The gases such as oxygen and nitrogen will be absorbed on activated carbon at normal refrigeration temperatures, -20°F to -40°F, and at a pressure of approximately 165 psia. The peculiar thermodynamic properties of helium will be used to assist the operation of the system. Hot gas will be piped directly from the compressor to regenerate the drying towers. By expanding the compressed helium from 165 psia to the normal operating pressure through turbines, the gas may be used as its own refrigerant and passed through a series of countercurrent heat exchangers between the activated carbon adsorption towers to reduce the temperature below that which can be obtained with a freon refrigerant system. Regeneration of the activated carbon will be accomplished by evacuation without change in temperature.

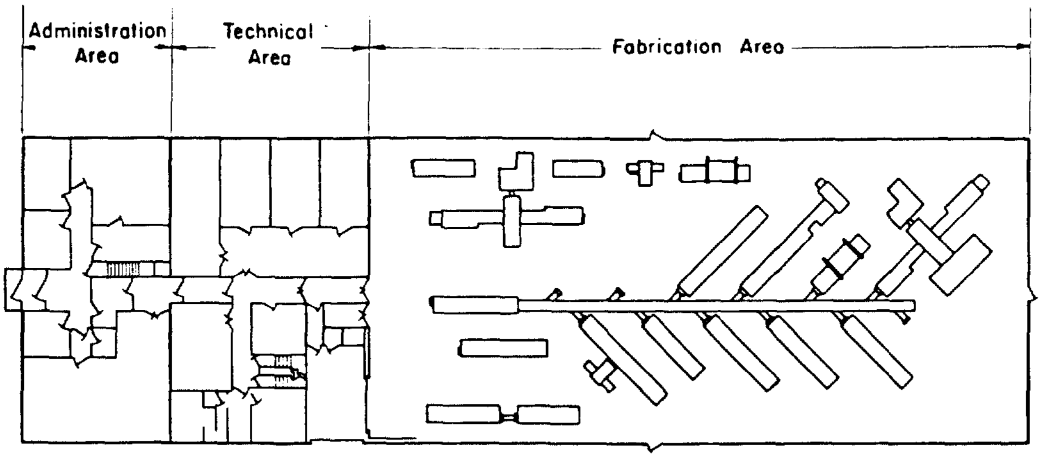


FIGURE I
BUILDING 350
FIRST FLOOR PLAN

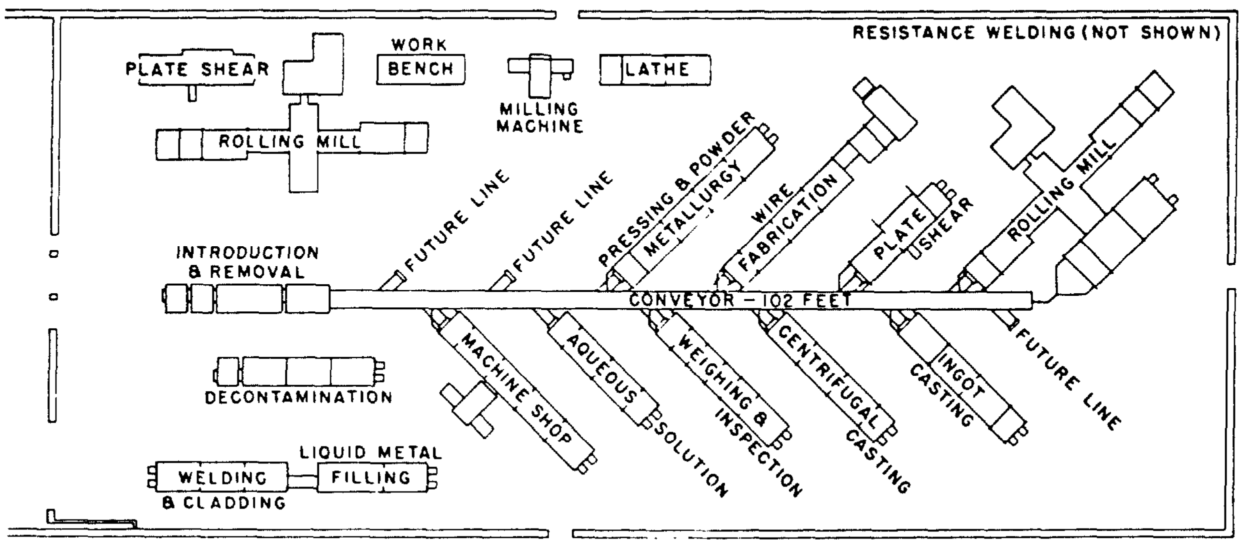


Fig. 2
FUEL FABRICATION FACILITY EQUIPMENT AND HOOD LAYOUT

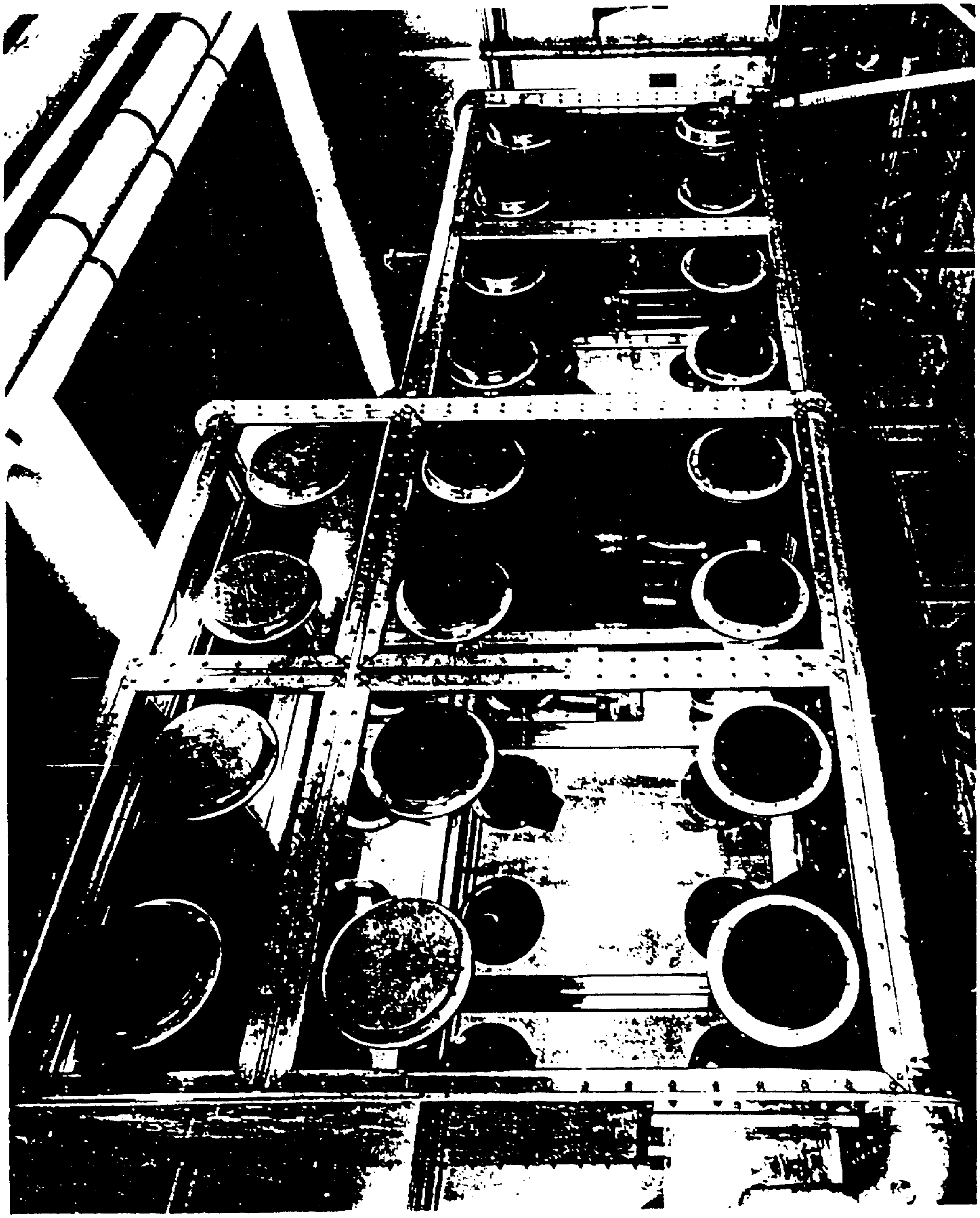


FIG. 3 - PROTOTYPE OF HOOD CONSTRUCTION FACILITY 350

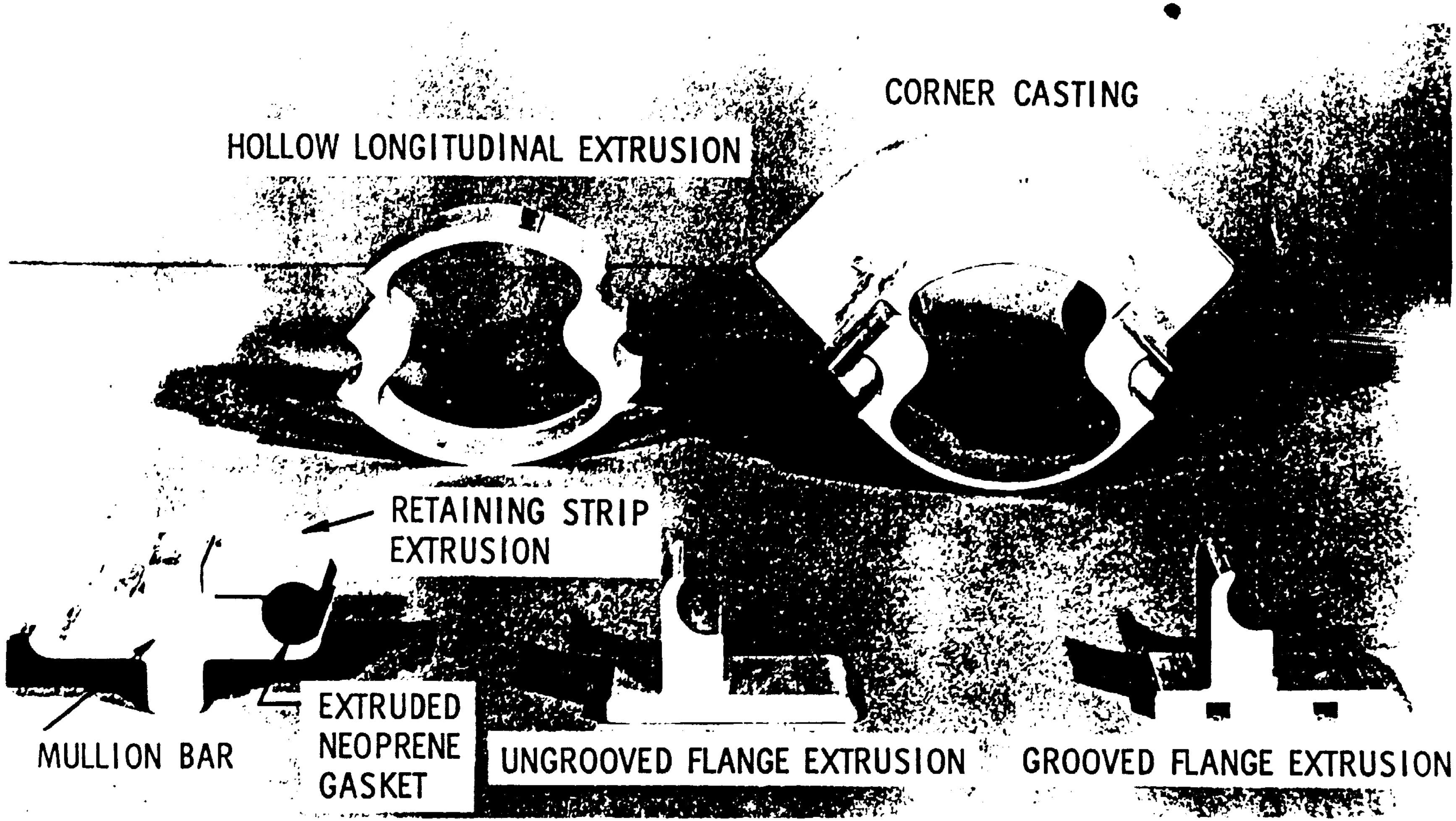


Fig. 4

SECTIONS OF ALUMINUM EXTRUSIONS AND CASTING USED FOR CONSTRUCTION OF THE HOOD FRAMES